

# White Paper Report

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## **White Paper**

Grant #: [HD5076609](#)

Project Title: Virtual Taxila: A Web-Accessible, Multi-User Virtual Environment (MUVE) of an Ancient Indian City

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## A. PROJECT ACTIVITIES

### *Background to the Site*

This final report documents our early efforts at creating a virtual reconstruction of the ancient South Asian city of Sirkap. Sirkap is part of the larger archaeological complex at Taxila, now located in the modern state of Pakistan, in the province of Punjab. The project is an attempt to apply twenty-first century technology to a first/second century CE cultural heritage. The archaeological complex at Taxila, of which Sirkap is one site, is located about twenty-two kilometers to the west of Islamabad, the capital of Pakistan, and about twenty-five kilometers to the northwest of the city of Rawalpindi (see Map 1). From the early sixth century BCE to the seventh century CE, Taxila was at the intersection of three great trade routes connecting India, Central Asia, and Western Asia. The site underwent many transformations in these fourteen centuries, but we focused on the middle city of Sirkap and chose to reconstruct it as it might have stood circa 100 CE.

Sirkap was excavated in the early twentieth century under the leadership of the British archaeologist Sir John Marshall. Marshall employed many workers over the course of thirteen excavation seasons, and the result is the largest horizontal excavation of an urban site in all of South Asia. Marshall's excavation report contains invaluable information on the fabric of urban life in the early centuries of the common era. Subsequent scholars have mined his work—there have been subsequent, smaller excavations as well as many studies, but Marshall is still the main source—in order to understand this period better. However, the vast majority of this analysis has remained in the pages of archaeological journals, PhD dissertations, and academic books to which the general public has little access. Thus, much of this important work has remained out of the public view.

The advent of immersive, interactive, Web-enabled, Multi User Virtual Environments (MUVES) has provided us with the opportunity to tell the story of Sirkap in a way that can help visitors experience this remarkable cultural heritage as it might have been in 100 CE. MUVES (which are a subclass of what is known popularly as MMOGs, Massively Multiplayer Online Games) are a new media vehicle that has the ability to communicate cultural heritage experience in a way that is a cross between filmmaking, video games, and architectural design. Unlike a film, it allows the observer to be an active participant in the experience. Unlike video games, its objective is not pure entertainment, but one of the appeals of such technology is that it teaches while it entertains. And unlike architectural design, it models—in addition to the built environment—also the people who inhabited the site and their rituals.

But this technology is relatively new, with a short history, devoid of a comprehensive theory, and short on useful precedents to guide the development of virtual cultural heritage experiences. It

certainly is a technology of illusion, creating an intangible reality. It freely borrows architectural principles, but can only be experienced through the proxy of avatars. Most importantly (and perhaps disturbingly), it requires filling in of missing details—architectural, social, ritualistic, and others—to create a ‘complete’ experience. Many of these details are based on conjecture and interpretation, informed by research, as explained below in this report. Therefore, we do not claim absolute historical accuracy; instead, we have tried to provide an experience that will convey, as best we can, the sense of ‘being’ at Sirkap in 100 CE.

### *Changes and Omissions to the Project*

There were two significant changes to the project. The first change was in the title of the project. “Virtual Taxila” became “Virtual Sirkap” as we realized that we would only be able to model a portion of the Middle City, Sirkap, and would not have the time or resources to model buildings or activities outside this ancient city. Virtual Sirkap, thus, more precisely defines the content of the model.

The second change was in the multi-player component of the project. At the moment, the three-dimensional virtual world is only available for download onto the visitor’s computer, and thus she can only visit it alone. This does not mean that the visitor is the only avatar in the model, there are many computer animated and controlled avatars (called “non-player characters” or NPCs) in the model. This change was due to an incompatibility in the operating system for Torque (the game engine in which we modeled our virtual world) and Claremont McKenna College’s vendor for a virtual server instance (Network Solutions). This incompatibility did not emerge until the February when we started to upload the completed model to our website. This incompatibility has set the multi-player component back a bit, but in the next few months we will be actively seeking solutions to this problem. For example, one solution might be to provide our own dedicated server to the college on which we can run the game engine. Thus, the project will be multi-player in the near future.

### *Efforts to Publicize the Project*

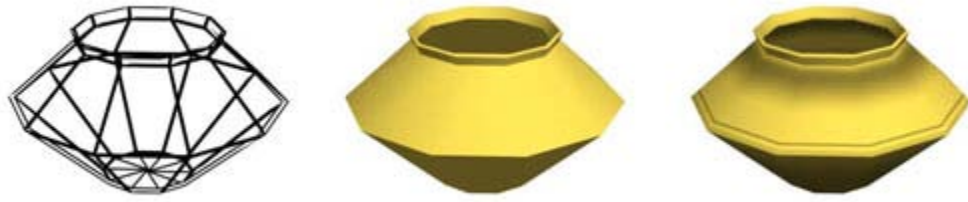
As mentioned above, we have made the model freely available for download to the general public by creating a website that not only hosts the game engine, but also contains a detailed description of the work done. Further, we will register the site on Heritage-Key, an online community which specializes in aggregating ancient worlds. An advantage of Heritage-Key is that users can post comments on their experience. Finally, we plan to write a paper on the educational value of the virtual world and present it at various conferences in 2011-2012.

## B. ACCOMPLISHMENTS

### *Quantitative and Qualitative Accomplishments*

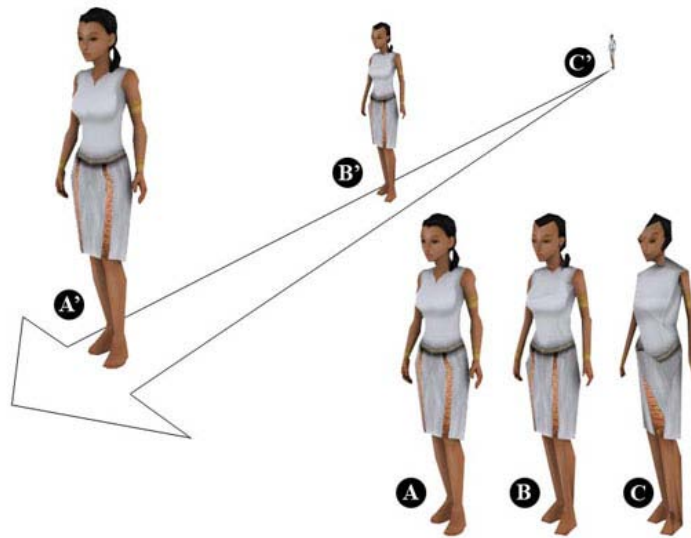
The project sacrificed quantitative coverage in modeling the city for qualitative detail in describing the methodological and theoretical issues. That is, the project team decided to model a smaller portion of the city so that we could provide detailed qualitative information. Thus, while we modeled ten city blocks (see Map 2) rather than the full twenty that have been excavated (or even further, sites outside the walled city of Sirkap), our website describes, in detail, the data obtained from the original excavation and how we interpreted those data to create our model. This was important for us as we believe that place is heterogeneous; it affords a multiplicity of mixed and sometimes contradicting meanings that juxtapose each other, and yet they do not negate each other. For example, a classroom may be understood simultaneously as a place of ecstasy by a student and a place of agony by her classmate. Ecstasy and agony co-exist within the class population despite their opposing meanings. Furthermore, the presence of one meaning does not necessary entail the absence of the other. This poses a theoretical problem since any representation of place, regardless of its mode or its medium, tends to emphasize one interpretation of the given place and ignores the others. In the case of our project, Virtual Sirkap represents one interpretation of the old city and inevitably ignores the rest. This is an inherent problem of representation that we try to reconcile by explicitly and critically addressing it in our website (and more fully in future papers).

For example, while one goal of the project was to achieve a seamless, real-time user experience, that is, an experience in which the technical factors melt into the background and the action becomes the focus, we also address the many factors that are at stake to achieve this real-time user experience, including the design of the environment, the number of users, the network capacity, and the computation power of both clients and server. Thus, to create a seamless real-time user experience, for example, the computational size of the buildings and artifacts in the model need to be constantly adjusted. So, on our website, we explain, using diagrams, the strategies we employed to achieve this effect. In the case of small, singular objects, such as a pot, one strategy to save computational stress is to represent the object by means of a simplified geometrical model. As designers, then, we can compensate for the loss of details by applying complex images as the model's texture (a "texture map"). Thus, all information pertaining to the artifact's details, surface texture, light and shadows, are "baked" into the image of the object's material (Figure 1).



**Figure 1:** From left to right, a model of a pot without a texture map, with a standard texture map, and with baked texture map.

Another strategy for the optimization of the environment is in the use of levels of detail (LoD). Most objects in the virtual environment have different alternative models with decreasing details and complexity. The richest model is computed when the object is closest to the camera while the poorest is computed when the object is furthest, significantly saving computation time. We used this strategy in the employment of NPCs (Figure 2).



**Figure 2:** Three levels of detail (LoD) used for a non-playing-character (NPC): A, B and C. A', B' and C' represent A, B and C respectively as they appear to the camera (the user) in the virtual environment. A is the richest in details while C is the poorest. The 3D graphics engine automatically replaces C with B and then with A as the NPC moves closer to the camera.

There are many other optimization strategies employed by game developers that we used in Virtual Sirkap and that we cannot explain in this final report due to space limitation. However, the purpose of exposing some of these strategies is to reflect on their impact on the representation of Sirkap.

## C. AUDIENCES AND CONTINUATION OF THE PROJECT

### *Audiences*

The project has two major audiences. (A) Students and other non-specialist visitors. The model enables non-specialists to gain access to the unique cultural heritage of early historic Sirkap through these new media technologies. Further, the construction of interactive narratives permits visitors to experience cultural heritage in a different way. And (B), specialists in the study of early historic India. However, it is important to note that the model, as it stands now, is not quite ready for the minute interrogation of specialists, but rather points to the potential that these kinds of virtual environments contain. The goal of the project, as a start-up project, was not architectural verisimilitude, nor did it attempt to portray a perfect simulation of early historic lifeways (for example, in modeling religious practice in this urban environment). Let us take up each of these limitations in more detail. First, to achieve architectural verisimilitude—for example modeling the lintels on the shrines with great detail—would increase the computational size of the model to the point where it would not function on an average computer. Certainly, we could have created a much more detailed model, but then visitors would need a dedicated, powerful computer to visit it. Once we decided to engage the general public, and by general public we mean those with common access to the worldwide web, we had to make sure the model functioned on a home computer of average computational ability with access to average levels of bandwidth for its multi-player option. With that said, there is no reason we cannot, in the future, provide a more detailed model to specialists. However, as the model stands right now, many of the buildings, and even more so the avatars, had to be rendered in a less detailed way to make the world actually function.

The issue with modeling the intangible heritage, for example religious practice, was the opposite of the above. While there is too much data to include in the architecture of the site, there is too little unproblematic evidence as to what kind of religious practice took place. In fact, there is much debate, for example, over exactly *how* the Apsidal Temple in Block D was used. We chose not to leave the site empty of intangible cultural heritage—that is empty of people actually doing something—but decided to move ahead and use imperfect evidence and to justify the choices we made in the project narrative provided on the website.

Despite these technical and scholarly limitations, Sirkap, we believe, is an excellent example of a site which benefits from a three-dimensional interactive environment. The interactive three-dimensional environment enables the scholar to experiment with new ways of visualizing, organizing, and presenting historical data in their geographic context. Of course, these new tools will not replace the traditional narrative forms of historical discourse; rather, they will augment them by being able to express spatial relationships in non-linear ways. As Stanford professor Richard White argues in his introduction to the value of two-dimensional renderings in Historical GIS, “Relationships that jump out when presented in a spatial format such as a map tend to clog narrative, choking its arteries until—even if the narrative does not expire—the reader,

overwhelmed by detail, is ready to die of tedium and confusion.”<sup>1</sup> We discovered that presenting data in spatial formats holds even more promise in its three dimensional capabilities. That is, the scholar who engages with an archaeological site map has a privileged point of view, that of the panopticon. Thus, for the scholar, the whole city is apprehended in one glance. On the two-dimensional page, the division between private and public space vanishes, and the logic of the map that reveals itself is one that no inhabitant would encounter. The inhabitant's experience of a city, on the other hand, is constrained by walls, closed doors, and limited sight-lines. The map-reader is subject to none of these restrictions. Three dimensional models allow the scholar to explore spatial variation from the ground up, as the inhabitants of the particular space would have experienced it. For example, just the “experience” of walking down the main street of Sirkap and being subject to all the visual limitations which come with being *in* the city, rather than being *above* the city as we are when we look at a site map, can be instructive.

### *Continuation of the Project (Future Plans)*

As this was a start-up grant, there is still much to do to make this project viable as an educational tool. Much of this grant period was spent figuring out the best practices for future design, and the process has been very fruitful. For example, one advantage of virtual worlds, we found, is that it encourages participatory learning. Participatory learning engages students’ imaginations. (Note: we did not engage primary school children, but rather gained feedback from limited testing with users with whom we were familiar. A testing stage with third-party students is still a task we need to complete. This kind of testing must abide by both Federal and University Policy on Human Subjects Research, and thus we more time). It draws their interests with powerful narratives and nudges them with puzzles they feel compelled to solve. Students’ hunger for challenge is evidenced in their fascination with video games. We can use the “gaming” aspect of video games in combination with learning goals to create educational modules for students. Below are a few avenues we would like to explore.

In the virtual world we are creating, learners could be given scripts, called *quests*, which introduce them to the social and historic issues of the day: art, entertainment, labor, religion, and education. These quests will offer learners a variety of entry points that allow them to consider questions that resonate with them. As they role play, interacting with fellow learners as well as non-playing characters, they can create a reciprocal feedback loop that enhances their imaginations and contributes to the development of a community of practice which comes to embody certain beliefs and behaviors. As the newcomers move from the periphery of this community to its center, they become more active and engaged within the culture and gradually assume the role of expert. Resources and tools that we can make available to learners in the game will offer them the opportunity of contextualizing their in-world experience with historical data that enlarges the meaning of their experiences. Learners can come to know the lives of the

<sup>1</sup> Richard White, "Foreword," in *Placing History: How Maps, Spatial Data, and GIS are Changing Historical Scholarship*, ed. Anne Kelly Knowles (Redlands: ESRI Press, 2008), p. x. GIS is the acronym for Geographical Information Systems.



characters they meet, their beliefs, values, and struggles. As learners share their understanding through presentations, we expect that they will participate not only in directing their study but in building collective understandings of the history they encounter.

A visitor might, for example, meet and talk with a character who describes a particular spiritual practice. The visitor is directed to a place of worship where she meets and talks with others. She decides that she wants to learn more about the historical roots of the practice and partners with two classmates in an investigation. Together they consult the project's homepage where they link to resources that include blogs, readings, films, artwork, artifacts and websites that deepen their understanding of the practice. The students make a film demonstrating their new knowledge and share it in-world to an audience of interested learners. Other presentations may include a group who has studied the trade routes between first century South Asia and the Mediterranean world, or a group that dramatizes a Buddhist story that may have been significant to the inhabitants. These groups then present their findings in a PowerPoint presentation which is linked within the actual model.

As the virtual world exists online, it can be freely accessed by learners from anywhere on the globe. University scholars might visit the site, and at the same time two classes of primary school students, one in the US and the other in Pakistan, can log on as well. The scholar can serve as a virtual tour guide as the students, as avatars so they can actually see representations of each other, follow along. They can ask questions, point to various architectural features, and explore together. The virtual world, then, becomes a meeting place where learning becomes a social activity that brings life to history and history to life. We have already been in contact with colleagues working on primary education in Pakistan, and we have discussed how we might make this "virtual classroom" a possibility. In this way, American students and Pakistani students can interact, explore, and learn about Pakistan's cultural heritage together. It is this possibility that pushed us to make sure that the world functioned on an average computer with an average internet connection as discussed above.

#### **D. EVALUATION, LONG TERM IMPACT, AND GRANT PRODUCTS**

As discussed above, the evaluation stage of the project is not quite complete. We have run informal tests, but when working with human subjects, and in particular primary school age students, we need to receive official approval from the various "Human Subjects Offices." This becomes even more complicated as we hope to engage students across the globe, and in particular in Pakistan. However, we think the potential of the Virtual Sirkap MUVE to not only educate students across the globe, but to create a space for interaction between American and Pakistani students, who obviously would have no other contact otherwise, is very exciting.

The primary grant product is the website we have created at [www.virtualsirkap.com](http://www.virtualsirkap.com).

## **Appendix: Maps and Figures**

Map 1: Location of Taxila in South Asia

Map 2: Marshall's Excavation Map of Sirkap (Area Modeled only)

*Figures 1 and 2 are in the main Final Performance Report*

Figure 3: Avatar Spawns Outside the Main Gate

Figures 4-7: Non-Player Characters (NPCs)

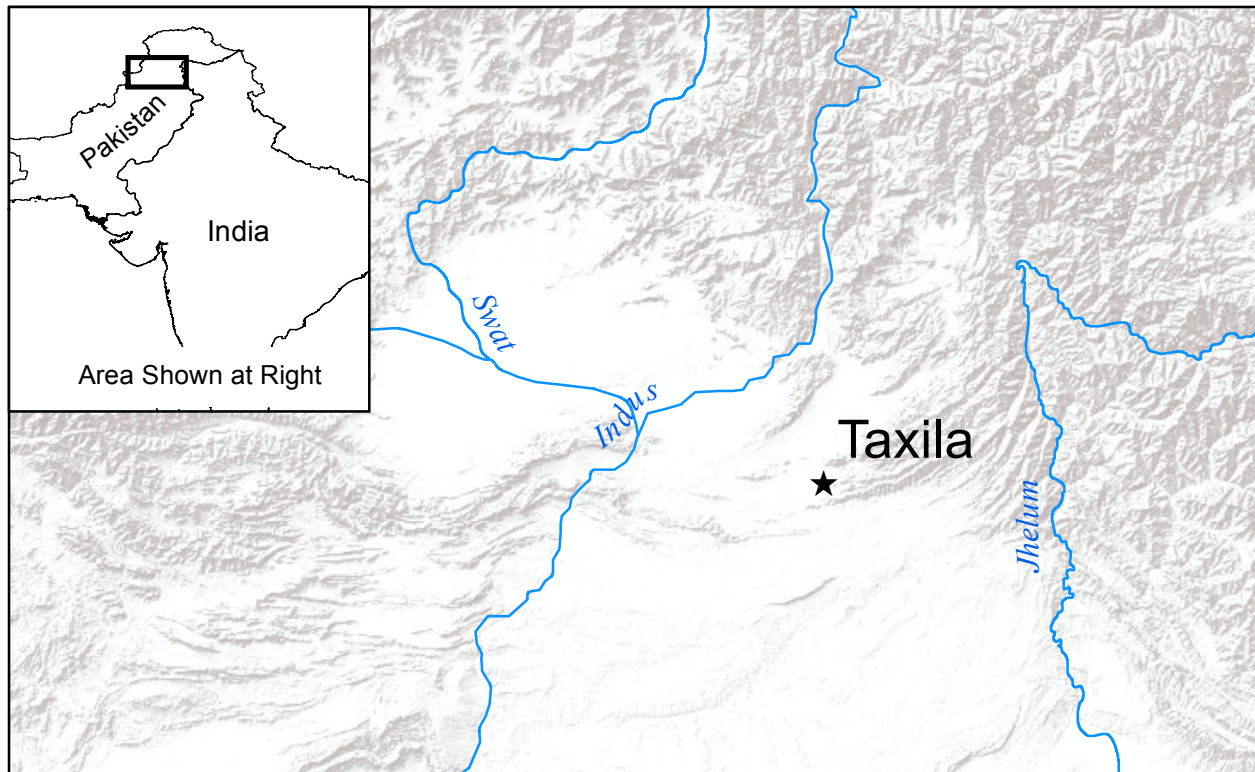
Figures 8 and 9: Two Views of Main Street

Figures 10 and 11: View of Apsidal Temple in Block D – From the Outside and Inner Courtyard

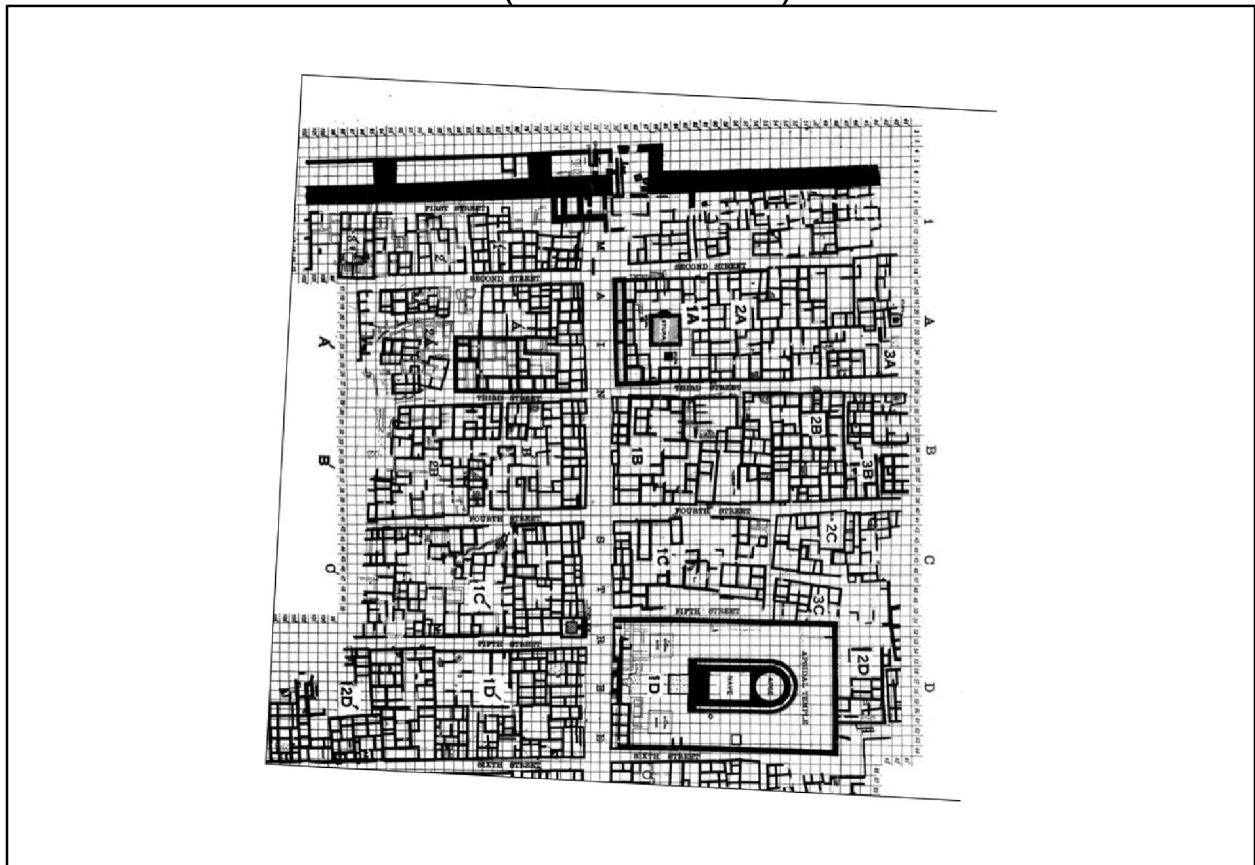
Figure 12: Inside Apsidal Temple in Block D

Figure 13: Arial View of the Model

Map 1: Location of Taxila in South Asia



Map 2: Marshall's Excavation Map of Sirkap  
(Area Modeled)



### **Figure 3: Avatar Spawns Outside the Main Gate**





The visitor “spawns” outside the main gate of the city. The visitor will not be able to explore very far outside the city, but rather will head directly through the main gate to start the experience.

The look of avatars has an impact on the interpretation of the environment in many ways. We decided to limit the users’ choice of avatars to either a male or a female modern-day looking avatar. This restriction conforms to our theoretical argument discussed on the website regarding the experience of Sirkap. By using a modern-day looking avatar we sought to reinforce the notion that this is a modern-day experience of Sirkap. Meanwhile, non-playing characters (NPCs), avatars controlled by artificial intelligence (AI) and not by actual users, were modeled to reflect the dress of the time when Sirkap was a vibrant place.



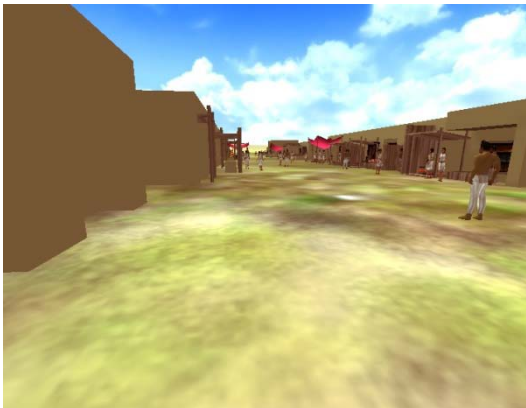
**Figures 4-7: Non-Player Characters (NPCs)**

The non-player characters are programmed to walk around the city and perform tasks such as selling goods, worshipping, and kneeling. Below are a few examples of NPCs that have stopped moving for a moment. Note that in the next iteration of this model, we need to create different types of NPCs. Here, we have one male type and one female type only.

NPCs Standing		NPCs Worshipping	
			

**Figure 8 and 9: Two Views of Main Street**

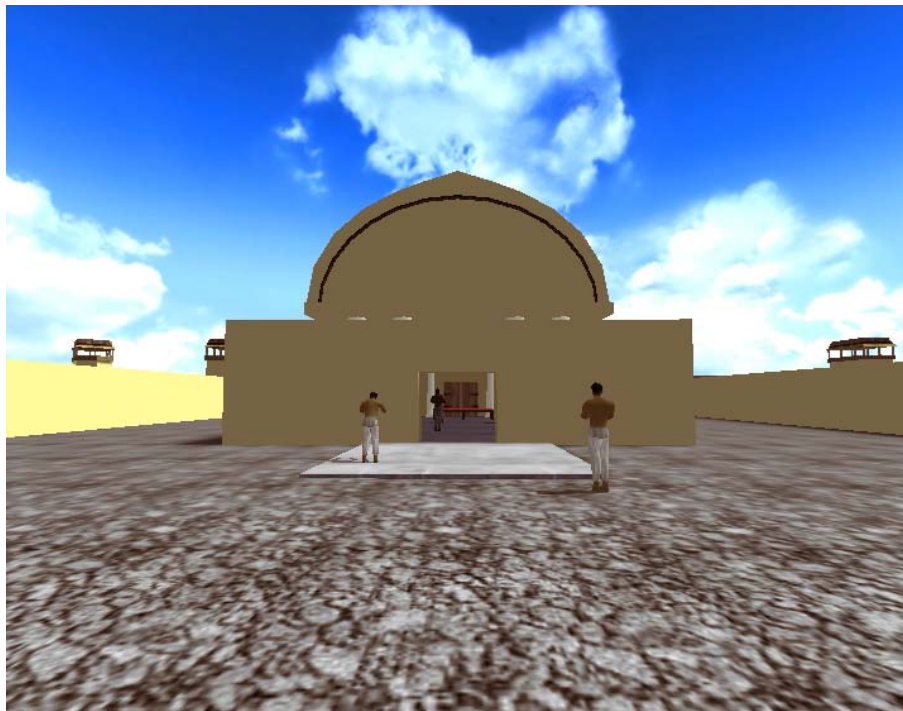
The visitor can walk up and down Main Street exploring the shops which sell garments, fruits, flowers, and pots. Also along Main Street are entrances to buildings and shrines, only those that would have been considered “public space” will be accessible to the visitor.





**Figure 10 and 11:**  
**View of Apsidal Temple in Block D – From the Outside and Inner Courtyard**

This is one of the largest public sacred spaces in the city of Sirkap.



**Figure 12: Inside Apsidal Temple in Block D**



**Figure 13: Arial View of the Model**

